**Note: This is an electronic version of my real logbook which will be present at the science fair**

November 22 2023

* Create question

-AI

-Healthcare

-Make healthcare better

* Question ideas

-How can AI help improve healthcare?

-What does AI do in healthcare?

-The Canadian healthcare system, what makes it different from the rest of the world’s?

*Edit(Nov.23): Talked with Mme Lam, helped me make question more precise, said to do stuff about prejudice*

 *-Discussed with Evrett, he suggested to do something with wait times*

 *-Thinking that my question may be How can AI help improve healthcare wait times*

*Edit 2(Nov 28): Made the question sound fancier, How can AI help shorten wait times and help eliminate prejudice in the healthcare system?*

December 19 2023

I wrote my first project proposal, based off of Mme Lam’s outline.

 **Science fair proposal**

  **Name:Reyna**

**Project Title:** Can AI Help Shorten Wait Times And Eliminate Prejudice In The Emergency Room?

**Question/Problem:** Can AI help shorten wait times and eliminate prejudice in the emergency room?

**Hypothesis:** Absolutely! AI is a valuable tool and can be applied nearly anywhere! With the help of AI we can create a digital tool to help order and rank different peoples symptoms putting those with higher risks first. This will take a lot of stress off of healthcare workers and speed up the accounting process. It will also help eliminate human prejudice in the emergency room as this digital tool will not have any personal ethics such as religion or culture and will therefore not be able to judge people based on race, gender, religion etc.

**Materials:** Computer, Magazines, books

**Step-by-step instructions**

1. Research AI
2. Write everything out
3. Edit
4. Further research
5. Make adjustments
6. Finalize
7. Write poster
8. edit+Finish

December 22 2023

Submitted Science club proposal. I will receive feedback after winter break.

January 6 2024

I talked to a family friend who does computer science. He told me that I should focus my research on LLMs. He told me that that would be the most effective way to execute a plan like that.

January 23 2024

I talked to my uncle and he told me about multimodal AI. I will research.

February 1 2024

Started researching today.

* A large language model is a type of generative AI that can learn with the help of large datasets. (drawn from the internet, and compiled and reviewed, can also be made)
* It can be taught to predict and generate new information. LLM can also be referred to as neural networks as they were inspired by the brain
* It takes time for these LLMs to learn and start to actually perform the task at hand. It takes a lot of data and effort to train these LLMs.
* To input data to start training a LLM we will most commonly use a transformer model which simply translates our datasets into a language which the computer will understand.
* Transformer models also work hand in hand with self attention mechanisms which enable the LLM to learn in a quicker and more efficient manner. It helps the LLM observe the entire phrase and observe context and syntax.
* unlike its older counterparts which would look at individual words in sequential manner without considering context.
* makes it much more efficient and accurate. Now this is just a small part of the technology behind LLM! Here are key components that contribute to an LLM!

*How else do LLMs affect our day to day lives?*

*Where else are they used?*

*How long have they been around?*

​​​

* <https://www.elastic.co/what-is/large-language-models>
* <https://huggingface.co/learn/nlp-course/en/chapter1/4>
* <https://www.youtube.com/watch?v=SZorAJ4I-sA>
* <https://www.youtube.com/watch?v=2IK3DFHRFfw>
* <https://www.youtube.com/watch?v=zjkBMFhNj_g>
* <https://www.elastic.co/what-is/vector-embedding>
* <https://www.elastic.co/what-is/vector-embedding>
* <https://www.youtube.com/watch?v=OxCpWwDCDFQ>
* <https://www.youtube.com/watch?v=qaWMOYf4ri8>
* <https://www.youtube.com/watch?v=jmmW0F0biz0>
* <https://txt.cohere.com/what-are-transformer-models/>
* <https://www.youtube.com/watch?v=UNmqTiOnRfg>
* <https://www.youtube.com/watch?v=y9PLF2GsD-c>

February 3 2024

Did more research today.

* embeddings we can turn words and sentences into numbers that a computer will understand.
* A vector is a way to represent numerically the word at hand. We use these so that the LLM which we are training can understand grammar and the meaning of words. What's more, it also helps the computer recognize patterns. There are many different types of embeddings, the most common being word embeddings, which represents each word as an individual and unique number.
* This is necessary in machine learning because it helps the LLM understand our languages in a more profound manner. It helps them put sentences into context and understand the difference between synonyms in different contexts.
* It helps the computer understand grammar and how it can affect your sentence. The more embeddings the better, but this can be very costly and take lots of time so what many companies use are multi-head embeddings.
* Multi-head embeddings are embeddings that are the product of modeling and altering other embeddings. These embeddings help the model create the best interpretation possible by running the same words over and over again. They are then given a score, interpretations with higher scores are given more value and are taken into consideration more.
* Embeddings group similar words with similar numbers, but this can be a problem when the same word has different meanings. The computer doesn't know the difference between the two.

*How did someone come up with this idea?*

*Why are embeddings so important?*

*Why can’t computers just process the information/words?*

* <https://www.elastic.co/what-is/large-language-models>
* <https://huggingface.co/learn/nlp-course/en/chapter1/4>
* <https://www.youtube.com/watch?v=SZorAJ4I-sA>
* <https://www.youtube.com/watch?v=2IK3DFHRFfw>
* <https://www.youtube.com/watch?v=zjkBMFhNj_g>
* <https://www.datacamp.com/tutorial/parameter-optimization-machine-learning-models>
* <https://www.youtube.com/watch?v=2wAOKIMJ9mI>
* <https://www.youtube.com/watch?v=tFHeUSJAYbE>
* <https://www.elastic.co/what-is/vector-embedding>
* <https://www.elastic.co/what-is/vector-embedding>
* <https://www.youtube.com/watch?v=OxCpWwDCDFQ>
* <https://www.youtube.com/watch?v=qaWMOYf4ri8>
* <https://www.youtube.com/watch?v=jmmW0F0biz0>
* <https://txt.cohere.com/what-are-transformer-models/>
* <https://www.youtube.com/watch?v=UNmqTiOnRfg>
* <https://www.youtube.com/watch?v=y9PLF2GsD-c>

February 5 2024

Did more research today again.

* The recurrent neural network is well recurrent. It is almost the same as a feedforward network just with an extra step.
* The information just goes straight through, instead it has an extra step that loops information back through the neural network.
* This gives the recurrent layer sequential memory.
* There can be a problem with this, over time as the recurrent network feeds information in that loop the recurrent network's memory of the first part of the sequence becomes smaller and smaller.
* The recurrent neural network can then forward information to the feedforward network where it is then processed and then a prediction is made.
* This layer helps the model observe the relationships between the words. It helps the model observe and improve its grammar and sentence structure.

*Why does the recurrent network forget things so easily?*

* <https://www.youtube.com/watch?v=UNmqTiOnRfg>
* <https://www.youtube.com/watch?v=y9PLF2GsD-c>
* <https://www.telusinternational.com/insights/ai-data/article/difference-between-cnn-and-rnn>
* <https://www.youtube.com/watch?v=AsNTP8Kwu80>
* <https://www.youtube.com/watch?v=LHXXI4-IEns>
* <https://www.youtube.com/watch?v=iR2O2GPbB0E>
* <https://www.youtube.com/watch?v=zizonToFXDs>

February 6 2024

More research done today as well.

* The feedforward layer is made up of multiple different layers that are all connected to each other, these layers transform the input embeddings.
* Different layers allow the model to predict the next word. We can assign specific scores to each word. so then when put in a sentence the model can associate these scores with a certain thing and decide which one it is.
* We can use positive and negative. If the word is positive like good, then it has a higher score. If the word is negative like bad it will have a lower score. If the word is neutral then it will have no score. So if we put in a sentence like "Carrots are good" the model will know that this sentence is positive because it has a higher score. If the sentence is "Carrots are bad" it will have a lower score. So the model will know that the sentence is bad. This is called sentiment training.

*Can you train the feedforward network to do anything?*

* <https://www.youtube.com/watch?v=y9PLF2GsD-c>
* <https://www.telusinternational.com/insights/ai-data/article/difference-between-cnn-and-rnn>
* <https://www.youtube.com/watch?v=AsNTP8Kwu80>
* <https://www.youtube.com/watch?v=LHXXI4-IEns>
* <https://www.youtube.com/watch?v=iR2O2GPbB0E>
* <https://www.youtube.com/watch?v=zizonToFXDs>
* <https://www.youtube.com/watch?v=OxCpWwDCDFQ>
* <https://www.youtube.com/watch?v=qaWMOYf4ri8>
* <https://www.youtube.com/watch?v=jmmW0F0biz0>
* <https://txt.cohere.com/what-are-transformer-models/>
* <https://www.youtube.com/watch?v=UNmqTiOnRfg>
* <https://www.youtube.com/watch?v=y9PLF2GsD-c>

February 8 2024

What did I do today, you guessed it, more research!

* The attention mechanism is what allows the model to focus on individual parts of text and it helps the model find keywords that are most relevant to the task at hand.
* It puts similar words into context by looking at the numbers assigned by the embeddings. The closer the numbers are together the more similar the words will be.
* So in a sentence it can be seen that these two words are similar so they must be related and therefore this is the meaning of this word.
* Self attention can also help the model with its grammar, it can see what it is saying in accordance with the input text. It can pay attention to its actions and what it is doing.

*How did someone create or come up with attention?*

* <https://www.youtube.com/watch?v=y9PLF2GsD-c>
* <https://www.telusinternational.com/insights/ai-data/article/difference-between-cnn-and-rnn>
* <https://www.youtube.com/watch?v=AsNTP8Kwu80>
* <https://www.youtube.com/watch?v=LHXXI4-IEns>
* <https://www.youtube.com/watch?v=iR2O2GPbB0E>
* <https://www.youtube.com/watch?v=zizonToFXDs>
* <https://www.youtube.com/watch?v=OxCpWwDCDFQ>
* <https://www.youtube.com/watch?v=qaWMOYf4ri8>
* <https://www.youtube.com/watch?v=jmmW0F0biz0>
* <https://txt.cohere.com/what-are-transformer-models/>
* <https://www.youtube.com/watch?v=UNmqTiOnRfg>
* <https://www.youtube.com/watch?v=y9PLF2GsD-c>

February 10 2024

More research!

* LLM are trained using large (Hence the name large language models) amounts of data. They use hundreds if not thousands of text sets that contain thousands of words.
* We feed all these enormous datasets to the LLM. This way the LLM can start to learn, it learns sentence structure and language.
* It will also learn context with the help of the feedforward and recurrent networks, it can learn to distinguish good from bad, hot from cold or really whatever you want it to.
* This type of training doesn't require as much human surveillance.
* If you want a LLM to perform a specific task then you have to be trained to that specific task.
* To do this then you have to create a specific dataset and start feeding it prompts from the dataset, were it is the put through the LLM over and over again, when it gets the answer wrong the LLM adjusts itself, it does this over and over again until it reaches a consistent answer. An example of this would be if we asked the LLM *"What colour is the sky?",* the first time it might say *"red",* this answer is obviously wrong so the LLM will adjust itself and the next time it might correctly say *"blue".* This is all done by itself. A
* After the LLM has trained itself we then ourselves start to ask a model questions, this is the second phase, human supervised training. The model learns how to respond to human text, and specific orders.
* <https://www.elastic.co/what-is/large-language-models>
* <https://huggingface.co/learn/nlp-course/en/chapter1/4>
* <https://www.youtube.com/watch?v=SZorAJ4I-sA>
* <https://www.youtube.com/watch?v=2IK3DFHRFfw>
* <https://www.youtube.com/watch?v=zjkBMFhNj_g>
* <https://www.elastic.co/what-is/vector-embedding>
* <https://www.elastic.co/what-is/vector-embedding>
* <https://www.youtube.com/watch?v=OxCpWwDCDFQ>
* <https://www.youtube.com/watch?v=qaWMOYf4ri8>
* <https://www.youtube.com/watch?v=jmmW0F0biz0>
* <https://txt.cohere.com/what-are-transformer-models/>
* <https://www.youtube.com/watch?v=UNmqTiOnRfg>
* <https://www.youtube.com/watch?v=y9PLF2GsD-c>

February 11 2024

Research was done today as well.

* Multimodel AI is a type of AI that can take multiple forms of data to create more precise and accurate predictions.
* Multimodal models take the next step and don't just draw on existing information, but are able to go further and create new data in the form of images, audio, text or numbers. Because multimodal AI can process many different types of data, it has access to so much more information.
* This helps it make much more developed answers and predictions! Not only this but a multimodal model will loop its answer and the users satisfaction back into the model so that it can form even more precise answers. This way the multimodal model can more closely imitate the human thought process.

**Input module**

* The input model is a series of neural networks whose job is to process all of the audio, text, and image data. Generally companies use different neural networks for each type of data.

**Fusion module**

* This model is responsible for putting everything together. It will fuse all the important or relevant data together, into even larger datasets, that will use the strengths of each type of input.

**Output module**

* This is the final product, this is the prediction, answer or recommendation the multimodal model has formed.

**Natural language processing (NLP)**

* This is how the multimodal model understands language. It helps the model pick up on sarcasm, or sentences with double meanings. It does this using many different tools. First it uses tokenization, which essentially breaks the sentence into individual parts, so in the sentence *"Mia was running very fast".* It would break it down into individual parts, so Mia would be one token. Then we use stemming and lemmatization to associate different words together and still understand what the individual word means. All this helps the multimodal model process audio and text.

**Computer vision**

* This is the mechanism that helps the multimodal model process images. It does this through lots and lots of training! We train it by using labeled images. It will compare the images to the labeled images, then when we feed it images, it will take a guess. At first the predictions will make no sense, but as it goes on the model becomes more and more accurate.

**Text analysis**

* This helps the model understand written text and the intent behind it.

**Integration systeme**

* This filters out unnecessary information and helps align and prioritize the many datasets.This is important for the multimodal model to understand context.

*Why is multimodal AI so much better, what differentiates it from LLMs?*

* <https://www.youtube.com/watch?v=WkoytlA3MoQ>
* <https://www.youtube.com/watch?v=-llkMpNH160>
* <https://www.kdnuggets.com/2023/03/multimodal-models-explained.html>
* <https://www.techtarget.com/searchenterpriseai/definition/multimodal-AI>
* https://www.splunk.com/en\_us/blog/learn/multimodal-ai.html#:~:text=Multimodal%20AI%20gives%20users%20the,produce%20both%20text%20and%20images.
* <https://ai.meta.com/tools/system-cards/multimodal-generative-ai-systems/>
* <https://www.aimesoft.com/multimodalai.html>
* <https://en.wikipedia.org/wiki/Multimodal_learning>
* <https://www.pecan.ai/blog/what-is-multimodal-ai-business/>
* <https://www.techopedia.com/definition/multimodal-ai-multimodal-artificial-intelligence>
* <https://www.youtube.com/watch?v=fLvJ8VdHLA0>
* <https://www.youtube.com/watch?v=CMrHM8a3hqw>
* <https://www.youtube.com/watch?v=OcycT1Jwsns>
* <https://www.youtube.com/watch?v=OcycT1Jwsns>

February 18 2024

I took a long break. More research today.

* AI in healthcare doesn't just stop there, it can also help the developments of new drugs! AI has helped in the development of the pfizer covid vaccine by processing information that would have taken them a month in a mere 22 hours!
* It can also help reconstruct and improve the quality of X-Rays and MRI scans! This makes it easier for doctors to identify small changes that would not have been seen in a lower quality scan.
* Not only does it help by reconstructing the image it will also lower the amount of time the patient has to spend in the MRI scanner. This can be advantageous for people who suffer from claustrophobia and high anxiety.
* AI has helped analyse x-rays and will examine and determine if it is normal. If it's flagged as abnormal it will be sent out to a doctor.
* Med-paLM 2 is the first AI tool to pass the medical licensing test. At first paLM passed with a score of 67% but just an astounding three months later it passed again with 85%. This is an incredible innovation because it shows that AI can accurately predict and diagnose humans just like a human. It proves that AI can actually help, in the medical field and that if we put aside pre-existing ideas, AI can help us revolutionize our healthcare system for the better.
* It can help you organize medical records and help you ask questions about your health to make sure you get the best care possible.
* What's more for humans it's basically impossible to memorize every medical condition or disease out there but not for AI, it can help doctors make more educated decisions by asking an LLM instead of having to scroll through different articles from Google.
* There are also many different apps that are already helping many people in their day to day lives. Think of every fitness, sleep monitoring, heart rate and blood pressure app out they all have AI as one of the key components.

*What are the limits of AI?*

*How close to a human can an LLM get.?*

*Could it develop consciousness?*

* <https://www.youtube.com/watch?v=2wAOKIMJ9mI>
* <https://www.youtube.com/watch?v=tFHeUSJAYbE>
* <https://www.frontiersin.org/articles/10.3389/fbrio.2023.1258159/full#:~:text=Vaccine%20design%20benefits%20from%20an,important%20step%20for%20vaccine%20development>.
* <https://www.pfizer.com/news/articles/how_a_novel_incubation_sandbox_helped_speed_up_data_analysis_in_pfizer_s_covid_19_vaccine_trial#:~:text=As%20Pfizer%20scientists%20raced%20to,to%20help%20achieve%20this%20mission>.
* <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10135995/>
* <https://www.youtube.com/watch?v=vTCSYIEnSJ8>
* <https://www.youtube.com/watch?v=KH-7A1RTn7Y>
* <https://www.youtube.com/watch?v=ZvNvgkD_myI>
* <https://www.youtube.com/watch?v=yME0KuI1s-Q>
* <https://www.youtube.com/watch?v=VA6buYNyr0s>
* Costco magazin
* <https://www.youtube.com/watch?v=uvqDTbusdUU>
* <https://www.youtube.com/watch?v=N3wJwz97b8A>
* <https://www.youtube.com/watch?v=3PbEgLw6lJ0>
* <https://www.youtube.com/watch?v=Nj2YSLPn6OY>
* <https://www.youtube.com/watch?v=4vBkzRJKBdk>
* <https://www.youtube.com/watch?v=32YgTYMhT4o>
* <https://www.youtube.com/watch?v=Et5HC8SR0BA>
* <https://www.youtube.com/watch?v=HrKzXLgGohA>
* <https://www.youtube.com/watch?v=9YB8WqJwc30>
* <https://www.youtube.com/watch?v=4oPpSFp87iE>
* <https://www.youtube.com/watch?v=ctRnh65cAeI>
* <https://www.youtube.com/watch?v=ZTp8r--YR84>
* <https://www.youtube.com/watch?v=mnKemC8HKjo>
* <https://www.youtube.com/watch?v=iFR24SDqlok>
* <https://whatfix.com/blog/technology-adoption-curve/>
* <https://www.youtube.com/watch?v=k_-Z_TkHMqA>
* <https://www.youtube.com/watch?v=MNp26DgKxOA>

February 21 2024

Today onto the more social side of things. Very sad stuff here.

* Joyce Echaquan, who filmed herself as she was strapped to a bed while she was pleading for help. The hospital staff appeared to be cold and indifferent whilst they hurled racist and rude insults. She was left sedated and when a nurse came to check on her a few hours later she was found dead on her hospital bed. This video she took raises so many issues and demonstrates that Canada is far from perfect in this regard.
* This is just one case out of many such as John Rivers, who after receiving a spinal tap test had many side effects but had to wait sixty days before receiving any medical attention. He was accused of faking his symptoms to be able to access narcotics.
* Carol Mcfadden an indigenous was told she shouldn't have come for an examination, she then put off having a breast screening for many years, she then discovered that she had stage four breast cancer.

*Why are people so cruel and discriminatory sometimes?*

*Why did we just decide one day that some people are better than others?*

* <https://www.cbc.ca/search?q=Racism%20in%20healthcare&section=all&sortOrder=relevance&media=all>
* <https://www.youtube.com/watch?v=CZcq_j8f7fw>
* <https://www.cbc.ca/player/play/2651743690>
* <https://www.cbc.ca/news/opinion/opinion-health-care-discrimination-rogene-reid-1.6607676>
* <https://www.cbc.ca/listen/live-radio/1-63-the-current/clip/15974700-calls-end-race-correction-health-care>
* <https://www.cbc.ca/news/canada/british-columbia/bc-tania-dick-anti-indigenous-nursing-racism-1.6970842>
* <https://www.cbc.ca/news/health/cmaj-anti-racism-1.6627312>
* <https://www.cbc.ca/news/health/antiracism-health-care-canada-indigenous-1.6801412>
* <https://www.cbc.ca/news/health/indigenous-women-health-care-inequities-1.6949274>
* <https://www.cbc.ca/search?q=racism%20in%20healthcare&section=all&sortOrder=relevance&media=all>
* <https://www.cbc.ca/player/play/2314479683549>
* <https://www.youtube.com/watch?v=7GmX5stT9rU>
* <https://www.youtube.com/watch?v=MVdKURnP6_Y>
* <https://www.youtube.com/watch?v=3U6lyjK5EIw>
* <https://www.youtube.com/watch?v=IXr-Cfj3EPM>
* <https://www.youtube.com/watch?v=40V43Iz0QCM>
* <https://www.youtube.com/watch?v=9crl-lcZOEk>
* <https://www.youtube.com/watch?v=jXpBkQnF8yI>
* <https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2810580#:~:text=Several%20studies%20have%20documented%20major,to%20their%20race%20and%20ethnicity.&text=Specifically%2C%20Black%20and%20Hispanic%20patients,symptoms%2C%20such%20as%20abdominal%20pain>.
* <https://www.aamc.org/news/bias-emergency-department>
* [https://www.thelancet.com/journals/eclinm/article/PIIS2589-5370(22)00255-3/fulltext](https://www.thelancet.com/journals/eclinm/article/PIIS2589-5370%2822%2900255-3/fulltext)
* <https://www.ohchr.org/sites/default/files/Documents/Issues/IPeoples/EMRIP/Health/UniversityManitoba.pdf>
* <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5698028/>
* <https://www.sac-isc.gc.ca/eng/1611863352025/1611863375715>
* <https://www.cfpc.ca/CFPC/media/Resources/Indigenous-Health/SystemicRacism_ENG.pdf>
* <https://www.cma.ca/latest-stories/challenging-anti-indigenous-racism-health-care>
* <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7697016/>
* <https://www.cna-aiic.ca/en/policy-advocacy/advocacy-priorities/racism-in-health-care>

February 23 2023

Just a picture today.

​​​The adoption curve which represents why it might take long for a widespread implementation to occur.

*Why are humans so skeptical about things?*

March 1 2024

I have been on the grind the past few days and have written out every thing. I kinda just transcribed my research to make it sound fancier. :)

​

## **Large Language Models**

 A large language model is a type of generative AI that can learn and improve with the help of large datasets. It can be taught to predict and generate new information. LLM can also be referred to as neural networks as they were inspired by the human brain! Much like the human brain it takes time for these LLMs to learn and start to actually perform the task at hand. It takes a lot of data and effort to train these LLMs. So how do these large language models work?

**Transformer's**

 To input data to start training a LLM we will most commonly use a transformer model which simply translates our datasets into a language which the computer will understand. We do this so that the computer can start to see patterns and wrap its "head" around the data given. Transformer models aren't the only thing at work here! Transformer models also work hand in hand with self attention mechanisms which enable the LLM to learn in a quicker and more efficient manner. It helps the LLM observe the entire phrase and observe context and syntax, which contrary to its older counterparts which would look at individual words in sequential manner without considering context, makes it much more efficient and accurate. Now this is just a small part of the technology behind LLM! Here are key components that contribute to an LLM!

​​​​​​​

**The embedding layer**

 Using embeddings we can turn words and sentences into numbers that a computer will understand. A vector is a way to represent numerically the word at hand. We use these so that the LLM which we are training can understand grammar and the meaning of words. What's more, it also helps the computer recognize patterns. There are many different types of embeddings, the most common being word embeddings, which represents each word as an individual and unique number. This is necessary in machine learning because it helps the LLM understand our languages in a more profound manner. It helps them put sentences into context and understand the difference between synonyms in different contexts. To add on to this it helps the computer understand grammar and how it can affect your sentence. The more embeddings the better, but this can be very costly and take lots of time so what many companies use are multi-head embeddings. Multi-head embeddings are embeddings that are the product of modeling and altering other embeddings. These embeddings help the model create the best interpretation possible by running the same words over and over again. They are then given a score, interpretations with higher scores are given more value and are taken into consideration more. The embedding interpretations are combined to create an even better embedding! Embeddings group similar words with similar numbers, but this can be a problem when the same word has different meanings. The computer doesn't know the difference between the two. This is why there are so many more layers necessary for a LLM to work smoothly!

**The feedforward layer**

 The feedforward layer is made up of multiple different layers that are all connected to each other, these layers transform the input embeddings. These different layers allow the model to predict the next word. We can assign specific scores to each word. so then when put in a sentence the model can associate these scores with a certain thing and decide which one it is. For example we can use positive and negative. If the word is positive like good, then it has a higher score. If the word is negative like bad it will have a lower score. If the word is neutral then it will have no score. So if we put in a sentence like "Carrots are good" the model will know that this sentence is positive because it has a higher score. If the sentence is "Carrots are bad" it will have a lower score. So the model will know that the sentence is bad. This is called sentiment training. You can use this type of training to reinforce or teach your model almost anything. This training helps the model predict the next word in the sentence and can also help the model gain a deeper understanding of what the person is trying to say!

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**The recurrent layer**

 The recurrent neural network is well recurrent. It is almost the same as a feedforward network just with an extra step. Instead of information just going straight through, instead it has an extra step that loops information back through the neural network. This gives the recurrent layer sequential memory. There can be a problem with this, over time as the recurrent network feeds information in that loop the recurrent network's memory of the first part of the sequence becomes smaller and smaller. Even so the recurrent network is still a very important part of a LLM. The recurrent neural network can then forward information to the feedforward network where it is then processed and then a prediction is made. This layer helps the model observe the relationships between the words. It helps the model observe and improve its grammar and sentence structure.

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**The attention mechanism**

 The attention mechanism is what allows the model to focus on individual parts of text and it helps the model find keywords that are most relevant to the task at hand. It puts similar words into context by looking at the numbers assigned by the embeddings. The closer the numbers are together the more similar the words will be. So in a sentence it can be seen that these two words are similar so they must be related and therefore this is the meaning of this word. Self attention can also help the model with its grammar, it can see what it is saying in accordance with the input text. It can pay attention to its actions and what it is doing.

**Training**

 LLM are trained using large (Hence the name large language models) amounts of data. They use hundreds if not thousands of text sets that contain thousands of words. We feed all these enormous datasets to the LLM. This way the LLM can start to learn, it learns sentence structure and language. It will also learn context with the help of the feedforward and recurrent networks, it can learn to distinguish good from bad, hot from cold or really whatever you want it to. One of the many advantages of this type of training is it doesn't require as much human surveillance.

**Fine-tuning+Prompt-tuning**

 If you want a LLM to perform a specific task then you have to be trained to that specific task. To do this then you have to create a specific dataset and start feeding it prompts from the dataset, were it is the put through the LLM over and over again, when it gets the answer wrong the LLM adjusts itself, it does this over and over again until it reaches a consistent answer. An example of this would be if we asked the LLM *"What colour is the sky?",* the first time it might say *"red",* this answer is obviously wrong so the LLM will adjust itself and the next time it might correctly say *"blue".* This is all done by itself. After the LLM has trained itself we then ourselves start to ask a model questions, this is the second phase, human supervised training. The model learns how to respond to human text, and specific orders. This improves its overall performance and makes it far more useful for human use!

## **Multimodel AI**

 Multimodel AI is a type of AI that can take multiple forms of data to create more precise and accurate predictions. Multimodal models take the next step and don't just draw on existing information, but are able to go further and create new data in the form of images, audio, text or numbers. Because multimodal AI can process many different types of data, it has access to so much more information. This helps it make much more developed answers and predictions! Not only this but a multimodal model will loop its answer and the users satisfaction back into the model so that it can form even more precise answers. This way the multimodal model can more closely imitate the human thought process.

**Input module**

 The input model is a series of neural networks whose job is to process all of the audio, text, and image data. Generally companies use different neural networks for each type of data.

**Fusion module**

 This model is responsible for putting everything together. It will fuse all the important or relevant data together, into even larger datasets, that will use the strengths of each type of input.

**Output module**

 This is the final product, this is the prediction, answer or recommendation the multimodal model has formed.

**Natural language processing (NLP)**

 This is how the multimodal model understands language. It helps the model pick up on sarcasm, or sentences with double meanings. It does this using many different tools. First it uses tokenization, which essentially breaks the sentence into individual parts, so in the sentence *"Mia was running very fast".* It would break it down into individual parts, so Mia would be one token. Then we use stemming and lemmatization to associate different words together and still understand what the individual word means. All this helps the multimodal model process audio and text.

**Computer vision**

 This is the mechanism that helps the multimodal model process images. It does this through lots and lots of training! We train it by using labeled images. It will compare the images to the labeled images, then when we feed it images, it will take a guess. At first the predictions will make no sense, but as it goes on the model becomes more and more accurate.

**Text analysis**

 This helps the model understand written text and the intent behind it.

**Integration systeme**

 This filters out unnecessary information and helps align and prioritize the many datasets.This is important for the multimodal model to understand context.

## **Racism and prejudice in the healthcare system**

 Canada is known around the world for being one of the most accepting countries. Even so racism and discrimination is still ever present in our society. There have been many many accounts of being denied service over racial or gender stereotypes. There have been many cases around the country of people of african or indigenous descent being denied care, under the pretense that they were faking it so that they could obtain narcotics. It doesn't even have to be full blown denial. Racism is also found in small and subtle dismissive action's, whether having your opinions brushed off by healthcare personnel or just simply being treated as inferior. This not only contributes to less care for people of minorities, but can also contribute to a fear around going to the doctors. When you are treated as inferior and dismissed when your simply going for a regular physical at a clinic, it doesn't exactly make one want to return. There have been many notable cases over the past few years such as Joyce Echaquan, who filmed herself as she was strapped to a bed while she was pleading for help. The hospital staff appeared to be cold and indifferent whilst they hurled racist and rude insults. She was left sedated and when a nurse came to check on her a few hours later she was found dead on her hospital bed. This video she took raises so many issues and demonstrates that Canada is far from perfect in this regard. This is just one case out of many such as John Rivers, who after receiving a spinal tap test had many side effects but had to wait sixty days before receiving any medical attention. He was accused of faking his symptoms to be able to access narcotics. Carol Mcfadden an indigenous was told she shouldn't have come for an examination, she then put off having a breast screening for many years, she then discovered that she had stage four breast cancer. These cases highlight that Canada has a systemic issue with racism within our healthcare system. This needs to change immediately. We need to make Canada's healthcare system a place where everyone feels safe and doesn't have to fear discrimination or malpractice in their annual physical. We need to strive together to create a better world for everyone.

## **Present day AI developments in healthcare**

 AI in healthcare doesn't just stop there, it can also help the developments of new drugs! AI has helped in the development of the pfizer covid vaccine by processing information that would have taken them a month in a mere 22 hours! It can also help reconstruct and improve the quality of X-Rays and MRI scans! This makes it easier for doctors to identify small changes that would not have been seen in a lower quality scan. Not only does it help by reconstructing the image it will also lower the amount of time the patient has to spend in the MRI scanner. This can be advantageous for people who suffer from claustrophobia and high anxiety. AI has helped analyse x-rays were it will examine x-rays and determine if it is normal. If its flagged as abnormal it will be sent out to a doctor. The AI has done this all by itself, this shows that AI can accurately predict and analyse images.

 Med-paLM 2 is the first AI tool to pass the medical licensing test. At first paLM passed with a score of 67% but just an astounding three months later it passed again with 85%. This is an incredible innovation because it shows that AI can accurately predict and diagnose humans just like a human. It proves that AI can actually help, in the medical field and that if we put aside pre-existing ideas, AI can help us revolutionize our healthcare system for the better.

 It can help you organize medical records and help you ask questions about your health to make sure you get the best care possible. What's more for humans it's basically impossible to memorize every medical condition or disease out there but not for AI, it can help doctors make more educated decisions by asking an LLM instead of having to scroll through different articles from Google. There are also many different apps that are already helping many people in their day to day lives. Think of every fitness, sleep monitoring, heart rate and blood pressure app out they all have AI as one of the key components. It has so many uses, which highlights the importance for widespread implementation of AI in the healthcare system!

## **Problems**

 There can be many problems associated with AI, as there is with any new advancements. Some of these problems can have to do with the AI itself, it can over diagnose or "hallucinate" were it will basically make things up, or get confused, be insufficient training data or incorrect assumptions, AI isn't perfect. Even if this is true we have made astounding developments in the past century and I am sure that we will make even more developments in the next few years. Another problem is human skepticism, there is a general distrust of AI. Even if we have all the technology it will take many years for AI to be accepted by humans. This is not to say we should put our complete trust in AI and technology. We still need to take everything AI says with a grain of salt because while AI is good it is not always 100% accurate.

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## March 5 2024

Wrote my problem and method today.

How can AI help shorten wait times and eliminate prejudice in the healthcare system? It's no secret that the past few years have put considerable strain on the healthcare system. This has led to waiting hours in the emergency room which can be the make or break for undetected life threatening diseases or injuries. Using AI we do part of the diagnoses beforehand and potentially save many lives in the process! Humanity will always and forever be a heavily biased and prejudiced species. It touches every aspect of our lives from the color of shirt you choose to which person you might select for a job interview. This is no different for healthcare workers. In Canada alone there have been many cases where people were refused care for racial or gender based reasons. Using AI we can make a safer and dependable system for all!

1. Make my question as precise as possible

2. Discuss with my teacher my plans for my science project

3. Do some brief research to get a general idea of my topic

4. Talk to friends or family who might be knowledgeable in the subject

5. Once I have a brief understanding of my project start real research (Look at websites, videos, magazines)

6. Write down all of my research (In logbook and on docs)

7. Review my sources to make sure there accurate + write my sources out

8. Write down my research in CYSF website

9. Edit all my writing

10. Review with my work with my teacher

11. Finalize everything for the due date

12. After due date obtain tri-fold

13. Write the things that will go on my board

14. Assemble my board

15. Practice my presentation (In front of family friends and teachers)

16. Make sure everything is in order and go set up at the science fair

17. Go to the science fair and present :)

 My idea is to have many little cubbies in the hospital waiting room where patients can go talk to an LLM. They will input their symptoms and unless race and gender was necessary to the diagnoses then it wouldn't ask. The symptoms would then be sent to a nurse or doctor who would then get an unbiased view of the symptoms. Having multiple cubbies would also speed up the wait times. The LLM could also help doctors organise paperwork so they can sleep more and take care of themselves.

March 7 2024

Wrote my data, conclusion and acknowledgements.

How can AI help improve our healthcare system? AI can help our healthcare system by shortening wait times, eliminating prejudice and creating a faster more reliable form of diagnoses! There are many different ways we can accomplish this, one of the most evident being a large language model (LLM) or multimodal AI models. If we have something like this on multiple different computers around the waiting room, we could help doctors and nurses save thousands of lives!

 Instead of going to the front desk and having to wait for hours just to see a nurse. You would put you symptoms into a computer which has been trained with enormous and diverse datasets so that you can receive a general diagnoses if it was life threatening it would be flagged as such, it would then be forwarded to a doctor so they could then take an unbiased look at your symptoms. This not only would help eliminate prejudice but would also help speed up wait times for potentially fatal illnesses or injuries. Aswell having multiple desks and computers to put in symptoms would speed up the wait times incredibly. Not only does this help patients but it takes a heavy load off of nurses and receptionists, who work hard everyday to make sure we get the care we need. They have to process hundreds of patients everyday and keep track of every single one of those patients. Having to do so much work like this, someone is bound to make a mistake. Which is why if AI and healthcare workers work together we can create a better, more reliable system for all!

Every year hundreds of patients are subject to the bias and prejudice of social workers. Even if done unintentionally we cannot deny that humans are heavily biased beings. We make unconscious assumptions about the people around us. This is why if we use AI that has been trained on hundreds of unbiased datasets we can make sure doctors get an unprejudiced view of a patient's symptoms. When a patient walks into a booth with a computer in it. The AI will ask their symptoms and unless race or gender is necessary for the diagnoses the AI will simply not ask. The information will be then sent to a qualified nurse or doctor who will get an unbiased look at the patient's symptoms. They can then make an early diagnosis without seeing the patient, they will eventually see the patient to make adjustments to the early diagnoses. They can use what the patient put into the computer as a reference and this can even help doctors recognize their own bias so that they can start moving away from prejudice. In a world where everyone has their own thoughts and opinions, AI can be a valuable tool to help eliminate that bias and make a safer, more equal world for all.

Humans are bound to make mistakes after all we are only, well human! When you're working long shifts and late hours, it is almost certain you will under diagnose or over diagnose a patient. AI, while still capable of making mistakes, is not affected by tiredness. It can constantly make informed decisions without being affected by its environment. Not only that but AI can help doctors cut back on their working hours. While doctors only are at the hospital for a certain number of hours they still have to do paperwork and organize information. AI can help take away this burden, by organizing and filling out paperwork for you. So doctors and nurses can get their well deserved sleep! Of course a human must check it, afterall AI is not perfect. Even so Ai is an extraordinary asset for doctors and nurses everywhere!

AI is one of humanity's greatest and most fast growing innovations to this day. We can use this incredible mechanism that will help make our health care systems a better place for all, by shortening wait times, eliminating prejudice and by helping out doctors make more accurate diagnoses. AI is the future of humanity whether we use it for better or worse that is entirely up to humanity. Even so, AI is a valuable tool to help make our world a better place for all Canadian citizens!

AI can help our healthcare system in many different ways, whether it's shortening wait times, stopping bias, or helping doctors and nurses, it is the future of humanity. A valuable partner, who can help us in many aspects of our lives. If we are able to implement a system in hospitals we help people of all walks of life. We can make way for a system that will help doctors become more unbiased, a system where people of minorities don't have to fear seeking medical aid. We can create a system where undetected life threatening injuries don't go undetected. A system where doctors can focus more on not just their patients health but their own. AI can help humanity in many different ways and it is up to us to make a brighter future for all!

I would like to thank my family for supporting me and helping me edit and practice my project. I would also like to thank my science club teacher Mme. Lam who helped and supported us every step of the way! I would also like to thank my friends who made this project ten times more fun! Thanks to my uncle who informed me and taught me more about AI. I would also like to thank my family friend Guy Davis who helped me kick start my project by informing me about LLM. Thank you to everyone who helped and supported me along the way!

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**Note: This is an electronic version of my real logbook which will be present at the science fair**

##